

CLAIMS

1. An aircraft warning light comprising an array of LEDs and an optical unit positioned in front of the array of LEDs, the optical unit being adapted to propagate fractions of the light emitted from the LEDs in selected directions in accordance with a predetermined angular distribution.

2. A warning light as in claim 1, wherein the light is a navigation warning light and the optical unit is adapted to redirect, in a substantially forward direction relative to the orientation of an aircraft to which the warning light is affixed, at least some of the light which otherwise would be emitted from the LEDs in a substantially lateral direction relative to the orientation of the aircraft.

3. A warning light as in claim 1, wherein the light is an anti-collision light and the optical unit is adapted to redirect, in a substantially horizontal direction relative to the orientation of an aircraft to which the warning light is affixed, at least some of the light which otherwise would be emitted from the LEDs in a substantially vertical direction relative to the orientation of the aircraft.

4. A warning light as in claim 1, wherein the optical unit is positioned with respect to the LED array such that substantially all of the light emitted from the LEDs is incident upon the optical unit.

5. A warning light as in claim 1, wherein the optical unit employs one or more of refractive optics, diffractive optics and total internal reflection-based optics.

6. A warning light as in claim 1, wherein the optical unit comprises a first optical structure adapted to collect light emitted from the LED array and propagate the collected light through the optical unit in a preselected direction.

7. A warning light as in claim 6, wherein the first optical structure comprises a plurality of lenses adapted to collect light from the LEDs incident upon the optical unit.

8. A warning light as in claim 7, wherein each of the LEDs is associated with a respective one of the plurality of lens.

9. A warning light as in claim 7, wherein the array of LEDs comprises a plurality of rows of LEDs and each of the rows is associated with a respective one of the plurality of lens.

10. A warning light as in claim 8, wherein each lens of the plurality lenses is positioned immediately in front of the LED with which the lens is associated.

11. A warning light as in claim 9, wherein each lens of the plurality lenses is positioned immediately in front of the row of LEDs with which the lens is associated.

13. A warning light as in claim 9, wherein each lens of said plurality of lenses is aspherical.

14. A warning light as in claim 12, wherein said optical unit further comprises total internal reflection structures.

15. A warning light as in claim 13, wherein said optical unit further comprises total internal reflection structures.

16. A warning light as in claim 6, wherein the optical unit further comprises a second optical structure adapted to transmit the collected light from the optical unit.

17. A warning light as in claim 16, wherein the second optical structure comprises one or more prisms adapted to propagate the collected light in accordance with the predetermined angular distribution.

18. A warning light as in claim 17, wherein the second optical structure comprises a plurality of prisms extending along one or both of the length and width of the LED array to form series of ridges on an outer surface of the optical unit.

19. A warning light as in claim 18, wherein the array of LEDs comprises a plurality of strings of LEDs, each string being connected in parallel with the other strings of said plurality of strings and comprising a plurality of LEDs

connected in series, and the prisms are positioned to extend across the LEDs of a plurality of the strings.

20. A warning light as in claim 19, wherein the strings of LEDs and the prisms are positioned orthogonally with respect to each other.

21. A warning light as in claim 2, wherein the optical unit comprises a transparent body having a first face provided with a first optical structure and a second face provided with a second optical structure, the second face being opposed to the first face, the first optical structure being in the form of a plurality of convex lenses and the second optical structure being in the form of one or more prisms, and the convex lenses being positioned with respect to the one or more prisms such that light from the optical unit is propagated in accordance with the predetermined angular distribution.

22. A warning light as in claim 3, wherein the optical unit comprises a transparent body having first and second opposed faces, the first face being provided with a plurality of aspherical cylindrical lenses.

23. A warning light as in claim 1, wherein the optical unit is formed as an integral part.

24. A warning light as in claim 23, wherein the optical unit is a molded, plastic element.

25. A warning light as in claim 1, further comprising a spacer adapted to position the optical unit at a selected distance from the LEDs.

26. A warning light as in claim 25, wherein the spacer is formed integrally with the optical unit.

27. A warning light as in claim 25, wherein the LEDs are encapsulated in a potting compound and the potting compound is formed at a predetermined depth to provide the spacer.

28. A warning light as in claim 1, wherein the LEDs are positioned with respect to the optical unit to provide a gap of up to 5 mm between the LEDs and the optical unit.

29. A warning light as in claim 1, wherein the LEDs are positioned with respect to the optical unit to provide a gap of between 0.3 mm and 2 mm between the LEDs and the optical unit.

30. A warning light as in claim 1, further comprising one or more IR LEDs.

31. An optical unit for use with an array of LEDs in an aircraft warning light, the optical unit comprising an optical structure adapted to propagate fractions of the light emitted from the LEDs in selected directions in accordance with a predetermined angular distribution.

32. An optical unit as in claim 31, wherein the aircraft warning light is a navigation light and the optical structure is adapted to redirect, in a substantially forward direction relative to the orientation of an aircraft to which the warning light is affixed, at least some of the light which

otherwise would be emitted from the LEDs in a substantially lateral direction relative to the orientation of the aircraft.

33. An optical unit as in claim 31, wherein the aircraft warning light is an anti-collision light and the optical structure is adapted to redirect, in a substantially horizontal direction relative to the orientation of an aircraft to which the warning light is affixed, at least some of the light which otherwise would be emitted from the LEDs in a substantially vertical direction relative to the orientation of the aircraft.

34. An optical unit as in any claim 32, wherein the optical unit employs one or more of refractive optics, diffractive optics and total internal reflection-based optics.

35. An optical unit as in claim 33, wherein the optical unit employs one or more of refractive optics, diffractive optics and total internal reflection-based optics.

36. An optical unit as in claim 31, wherein the optical structure comprises a first optical structure adapted to collect light emitted from the array of LEDs and a second optical structure adapted to propagate the collected light in the predetermined angular distribution.

37. An optical unit as in claim 36, wherein the first optical structure includes a plurality of lenses positioned on one surface of the optical unit.

38. An optical unit as in claim 37, wherein each of the lenses is positioned to correspond with a respective one of the LEDs.

39. An optical unit as in claim 36, wherein the array of LEDs comprises a plurality of rows of LEDs, the first optical structure comprises a plurality of lenses positioned on one surface of the optical unit, and each of the lenses is positioned to correspond with a respective one of the rows.

40. An optical unit as in claim 37, wherein the second optical structure comprises one or more prisms positioned on a surface of the optical unit opposite to the one surface.

41. An optical unit as in claim 32, wherein the optical unit comprises a transparent molded body having first and second opposed faces, the first face being provided with a plurality of convex lenses and the second face being provided with one or more prisms, and the convex lenses being positioned with respect to the one or more prisms such that light from the optical unit is propagated in accordance with the predetermined angular distribution.

42. An optical unit as in claim 40, wherein the prisms extend along one or both of the length and width of the array of LEDs and form a series of ridges.

43. An optical unit as in claim 41, wherein the prisms extend along one or both of the length and width of the array of LEDs and form a series of ridges.

44. An optical unit as in claim 33, wherein the optical unit comprises a transparent molded body having first and second opposed faces, the first face being provided with a plurality of aspherical lenses and the second face being substantially planar.

45. An optical unit as in claim 33, wherein the optical unit comprises a transparent molded body having first and second opposed faces, the first face being provided with a plurality of convex lenses and total internal reflection structures and the second face being provided with a plurality of convex lenses.

46. An optical unit as in claim 45, wherein the lenses on the second face comprise cylindrical or anamorphic lenses.

47. A lamp unit for an aircraft warning light comprising an array of LEDs, an optical unit having an optical structure adapted to propagate fractions of light emitted from the LEDs in selected directions in accordance with a predetermined angular distribution, and spacing means for holding the optical unit at a fixed distance from the LEDs.

48. A lamp unit as in claim 47, wherein the aircraft warning light is a navigation light and the optical structure is adapted to redirect, in a substantially forward direction relative to the orientation of an aircraft to which the warning light is affixed, at least some of the light which

otherwise would be emitted from the LEDs in a substantially lateral direction relative to the orientation of the aircraft.

49. A lamp unit as in claim 47, wherein the aircraft warning light is an anti-collision light and the optical structure is adapted to redirect, in a substantially horizontal direction relative to the orientation of an aircraft to which the warning light is affixed, at least some of the light which otherwise would be emitted from the LEDs in a substantially vertical direction relative to the orientation of the aircraft.

50. A lamp unit as in any claim 48, wherein the optical unit employs one or more of refractive optics, diffractive optics and total internal reflection-based optics.

51. A lamp unit as in claim 49, wherein the optical unit employs one or more of refractive optics, diffractive optics and total internal reflection-based optics.

52. A lamp unit as in claim 47, wherein the optical structure comprises a first optical structure adapted to collect light emitted from the LEDs and a second optical structure adapted to propagate the collected light in the predetermined angular distribution.

53. A lamp unit as in claim 52, wherein the first optical structure includes a plurality of lenses positioned on one surface of the optical unit.

54. A lamp unit as in claim 53, wherein each of the lenses is positioned to correspond with a respective one of the LEDs.

55. A lamp unit as in claim 52, wherein the array of LEDs comprises a plurality of rows of LEDs, the first optical structure comprises a plurality of lenses positioned on one surface of the optical unit, and each of the lenses is positioned to correspond with a respective one of the rows.

56. A lamp unit as in claim 53, wherein the second optical structure comprises one or more prisms positioned on a surface of the optical unit opposite to the one surface.

57. A lamp unit as in claim 48, wherein the optical unit comprises a transparent molded body having first and second opposed faces, the first face being provided with a plurality of convex lenses and the second face being provided with one or more prisms, and the convex lenses being positioned with respect to the one or more prisms such that light from the optical unit is propagated in accordance with the predetermined angular distribution.

58. A lamp unit as in claim 56, wherein the prisms extend along one or both of the length and width of the array of LEDs and form a series of ridges.

59. A lamp unit as in claim 57, wherein the prisms extend along one or both of the length and width of the array of LEDs and form a series of ridges.

60. A lamp unit as in claim 49, wherein the optical unit comprises a transparent molded body having first and second opposed faces, the first face being provided with a plurality of aspherical lenses and the second face being substantially planar.

61. A lamp unit as in claim 49, wherein the optical unit comprises a transparent molded body having first and second opposed faces, the first face being provided with a plurality of convex lenses and total internal reflection structures and the second face being provided with a plurality of convex lenses.

62. A lamp unit as in claim 61, wherein the lenses on the second face comprise cylindrical or anamorphic lenses.